

Functional Results of Different Repair Techniques for Knee Articular Cartilage Lesions

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The articular cartilage lesions are frequent and highly affect the patient's quality of life. Although remarkable progress in the treatment of focal lesions of articular cartilage were lately made, controversies still exist regarding the treatment options. The main purpose of this study was to evaluate and compare the preoperative and 6 months postoperative knee functional scores of patients undergoing arthroscopic repair of knee chondral lesions by: debridement, microfractures, osteochondral autograft transplantation and autologous matrix-induced chondrogenesis. Chondral reconstruction with collagen membranes and osteochondral autograft transplantation techniques showed a superior result at 6 months postoperatively compared to microfracture techniques and mechanical debridement.

Keywords: chondral defects, mosaicplasty, collagen membrane, microfractures

The articular cartilage lesions have a high incidence consisting in 10-12% of the general population, especially at the knee level [1]. During knee arthroscopies, these lesions are diagnosed in up to 20% of cases. [3] Although some of these lesions are asymptomatic, most patients are complaining of symptoms ranging from occasional pain to disability.

Because of its impaired vascularization and innervation, the intense mechanical stress at this level makes the articular cartilage prone to injuries. Low vascularization also leads to a decreased ability of spontaneous healing of the lesions [4, 5].

Recent years have shown a remarkable progress in the treatment of focal articular cartilage lesions, but the problem is still under debate, with many studies being conducted on this subject. None of the methods used in recent medical practice have proven their superiority.

The most commonly used technique that is the mechanical debridement of lesions, seems no longer to be a suitable solution in the treatment of cartilage lesions when used alone, according to recent studies in the field. [1]. On the other hand, the medullary stimulation techniques by producing microfractures (MF) in the subchondral bone promotes the recruitment of mesenchymal cells, with the formation of a fibrin clot which subsequently transforms into a fibrocartilage with lower biomechanical properties compared to hyaline cartilage [6].

Osteochondral autograft transplantation/mosaicplasty (OATS) involves the extraction of cylinders of bone and healthy cartilage from peripheral, non-weight-bearing areas of the femoral trochlea, and their press-fit implantation in the receiving areas of the injured articular cartilage.

Applying collagen membranes after subchondral microfractures represents an evolution of the microfracture technique. The AMIC® technique (Autologous Matrix-Induced Chondrogenesis) provides a suitable local environment for cellular differentiation, with the formation of an articular cartilage with a morphological aspect close to normal [7].

The main purpose of this study is to evaluate and compare the preoperative and 6 months postoperative knee functional scores of patients who benefited from arthroscopic repair of knee chondral lesions with different techniques. The study hypothesis is that osteochondral autograft transplantation and autologous matrix-induced chondrogenesis will have better mid-term functional results than debridement and microfractures.

Experimental part

A retrospective review was performed on all the knee arthroscopies carried out in the Orthopedics and Traumatology Clinic of Cluj-Napoca, between 2013 and 2017. The surgical interventions were accomplished by the same surgical team led by an orthopedic surgeon, experienced in arthroscopic surgery and in the treatment of cartilage lesions. The inclusion criteria in the study were patients with diagnosis of Outerbridge III and IV cartilage lesion.

The exclusion criteria were represented by: superficial injuries of the cartilage (Outerbridge I and II), cases with total meniscectomy, revision surgery of articular cartilage and patients with rheumatoid arthritis.

Baseline data collection included age, gender, size of lesion, number and localization of the cartilage lesions (medial or lateral femoral condyle, femoral trochlea, patella, medial or lateral tibial plateau), surgical history, associated lesions and specific treatment. Therapeutic outcome was assessed by the functional scores (IKDC = International Knee Documentation Committee subjective and objective) performed preoperatively and postoperatively at 6 months for patients in the treatment groups.

Between 2013 and 2017, a number of 512 knee arthroscopies were performed. Among these cases, 240 patients (46% of total arthroscopies) had articular cartilage lesions of varying stages and were included in the study. We have excluded 134 cases (55% of the total number of cartilage lesions), because of the presence of at least one of the exclusion criteria.

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		I. Debridement	II. Microfractures	III. Osteochondral transfer	IV. Collagen membrane
Number		53	37	9	7
Age \pm SD		41.94 \pm 14.89 [18-70]	39.05 \pm 14.54 [18-68]	30.11 \pm 12.17 [16-53]	34 \pm 10.26 [19-44]
Gender M/F		32/21	22/15	7/2	4/3
Defect size	< 1cm ²	14	4	4	-
	1-2 cm ²	30	16	5	1
	2-4 cm ²	9	17	-	6
Defect localization	MFC	31	30	4	2
	LFC	7	8	4	4
	TROC	10	4	1	0
	PAT	31	11	3	2
	MTP	8	3	0	0
	LTP	4	1	0	1

Table 1
PATIENTS
DEMOGRAPHICS
AND CHONDRAL
CHARACTERISTICS

*MFC = medial femoral condyle; LFC = lateral femoral condyle; TROC= femoral trochlea; PAT = patella; MTP = medial tibial plateau; LTP = lateral tibial plateau

Associated lesions	Nr. cases	Concomitant procedures	Nr. cases
Medial meniscus	74	Meniscectomy	76
Anterior cruciate ligament (ACL)	34	ACL reconstruction	34
Osteoarthritis of the knee	24	Synovectomy	20
Lateral meniscus	23	Suture of meniscus	19
Hypertrophic synovitis	20	Loose body removal	13
Intra-articular loose bodies	13	Corrective osteotomy	2
Genu valgum	2	Tibial tubercle transposition	2
Patellar instability \pm recurrent dislocation	2		

Table 2
ASSOCIATED LESIONS OF CARTILAGE DEFECTS
AND THE CONCOMITANT PROCEDURES

A retrospective, observational study was performed on a group of 106 patients aged 16-70 years, M/F 65/41, with grade III or IV Outerbridge cartilage lesions who met the inclusion criteria in the study (table 1). The lesions observed were focal, bounded by healthy cartilage tissue, even if the joints exhibited signs of low grade arthritic degradation. The associated lesions are presented in table 2.

Postoperative complications included 28 cases of post-surgical local hematomas and 3 cases of deep vein thrombosis, which all had a very good evolution under treatment and did not significantly affect the healing processes or the rehabilitation, therefore the patients were included in the present study.

The cases were divided into four groups (I- IV) according to the surgical technique used: *group I* - arthroscopic debridement of cartilage lesions; *group II* - microfractures; *group III* - osteochondral transfer and *group IV* - Autologous Matrix-Induced Chondrogenesis (AMIC).

The therapeutic methods were applied according to the number and size of lesions, their location and the functional needs of patient. The surgical interventions performed were the following: *Arthroscopic Debridement* (fig. 1.a); *Microfractures (MF)* (fig. 1.b); *Osteochondral transfer - mosaicplasty (OATS)* - The osteochondral graft was transferred from a donor site of a relatively non weight bearing to the level of the lesion after debridement (fig. 1.c); *Autologous Matrix-Induced Chondrogenesis (AMIC)* - we used the reference bilayer collagen type I and III matrix membrane (Chondro-Gide® from Geistlich Pharma AG, Switzerland), which was sealed in position with a fibrin adhesive (Tisseel Lyo®, Baxter, Deerfield, IL, USA) (fig. 1.d) on top of the subchondral microfractures. Postoperatively, each patient followed a standard rehabilitation protocol described by Steadman et al [8], depending on the type of intervention to which he was subjected.

IKDC scores, recorded preoperatively and postoperatively at 6 months, were compared in each of the four groups. The differences of the postoperative values of the IKDC scores between the four groups were analyzed. Moreover, it was further assessed whether there are any

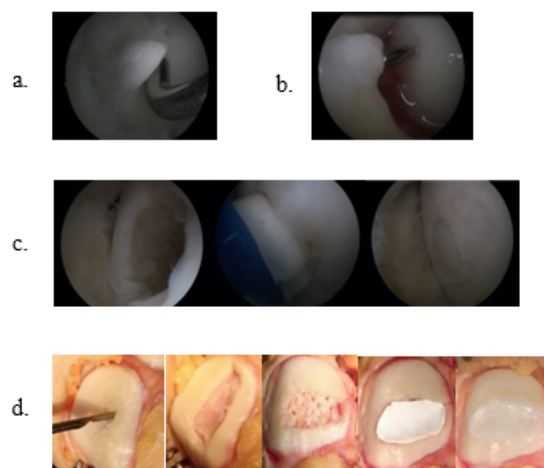


Fig. 1. Representative cases of patients undergoing arthroscopic debridement (a), microfractures (b), osteochondral transfer (c) and chondral reconstruction with collagen membrane sealed (d)

correlations between patient's age, degree of chondral lesion and postoperative IKDC subjective score.

For statistical analysis, SPSS program, version 22 for Windows was utilized. Descriptive statistics were performed for all parameters, each being expressed by mean, standard deviation and extreme values of the group. Study groups were compared by two-tail Student t-test for independent variables. Pearson coefficient was used to establish correlations between the variables. The significance limit was established as $p < 0.05$.

Results and discussions

According to table 3, all the four groups showed a statistically significant increase of postoperative IKDC subjective scores compared to the preoperative values ($p < 0.01$). The patients from group IV had significant lower preoperative IKDC subjective scores, compared to group I ($p < 0.001$) and group II ($p = 0.01$) and group III ($p = 0.037$). Moreover, there were no statistical differences of postoperative IKDC subjective score between the groups ($p > 0.05$). The highest increase was observed in group IV

Group	IKDC S preop.	IKDC S postop.
I. Debridement	61.32 ± 7.95 [48-85]	70.57* ± 9.13 [51-95]
II. Microfractures	56.17 ± 12.97 [32-79]	71.75* ± 13.37 [47-92]
III. OATS	51.14 ± 16.68 [33-79]	76.43* ± 13.45 [59-91]
IV. AMIC	41.86 ± 15.37 [21-65]	76.14* ± 12.05 [52-89]

*statistically significant compared to preoperative values (p<0.001)

(p<0.0001). Starting from lowest preoperative functional scores, patients in groups III and IV managed to increase IKDC subjective scores more in comparison to patients in groups I and II (fig. 2).

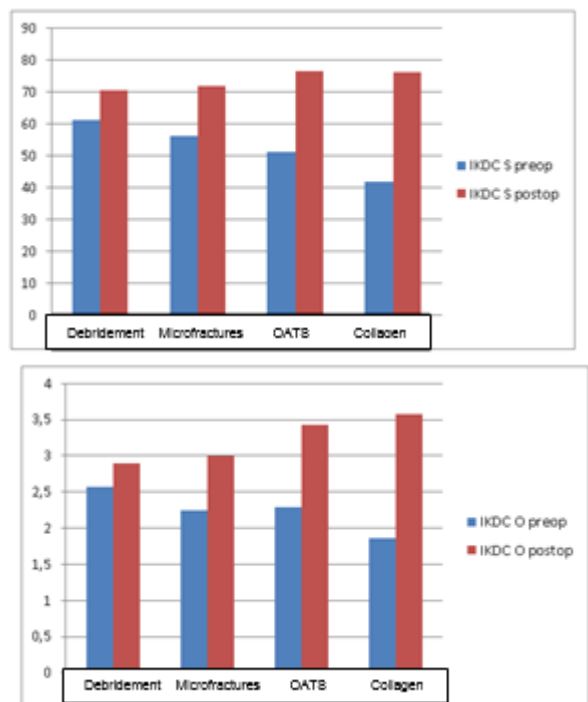


Fig. 2 Comparison of the IKDC S and O scores, pre and postoperative

The postoperative IKDC objective scores was significantly higher in all four groups compared to the preoperative values (p<0.001). Regarding the preoperative IKDC objective score, group IV revealed lower values with statistical significance compared with group I (p=0.031). In contrast, the postoperative values were higher in group IV (3.57±0.53) compared with those from group I (2.89±0.57, p=0.023), group II (3±0.66, p=0.1) and group III (3.43±0.53, p=0.87). Moreover, the patients from group III and IV showed an improvement regarding the functional class. After the intervention, there were no C or D IKDC objective scores recorded (table 4).

Table 4

COMPARISON OF PRE- AND POSTOPERATIVE IKDC OBJECTIVE SCORES

Group	Number of patients							
	IKDC O preop.				IKDC O postop.			
	A	B	C	D	A	B	C	D
I. Debridement	1	19	17	0	4	25	8	0
II. Micro-fractures	0	7	16	1	5	14	5	0
III. OATS	0	2	5	0	4	3	0	0
IV. AMIC	0	1	4	2	4	3	0	0

No statistically significant correlations were obtained between the degree of chondral lesion (Outerbridge III or IV) and IKDC scores (P>0.05). A moderate negative correlation between IKDC S postoperative scores and the patient's age. (P(T<=t) =0.02)

The main finding of this study was a better knee functional results using the AMIC technique or OATS,

Table 3
COMPARISON OF PRE- AND POSTOPERATIVE IKDC
SUBJECTIVE MEAN SCORES

confirmed by a statistically significant difference between postoperative IKDC functional score at 6 months compared to the preoperative score over more traditional methods (microfractures, debridement). We have not found studies that directly compare mosaicplasty technique (OATS) with AMIC technique in the literature.

Other authors showed that in short, medium and long term, mosaicplasty has superior results compared to microfractures for a solitary cartilage defect of up to 5 cm located at the medial femoral condyle [9]. On the other hand, Aroen shows that on a long-term basis, the results obtained by MF are comparable to those obtained through OATS, without being able to draw a final conclusion due to the small number of patients included in the study [2].

A randomized clinical trial comparing the 3 methods (debridement, MF and OATS) in patients with associated anterior cruciate ligament (ACL) lesions that benefited concurrently from ACL reconstruction, showed that patients in the OATS group achieved higher functional scores at 3 years compared to MF and debridement. [10] Other studies conclude that mosaicplasty versus MF results translate into a superior clinical outcome and anatomically superior aspect at arthroscopic second-look, achieving a higher level of sports activity [9-16].

Pareek et al following a comprehensive review note that there is a large variability in patient age, initial activity level, associated lesions, location and defect size in the reviewed studies, so that the superiority of the OATS method over the MF can't be generalized to all patients. [17] Mechanical debridement of injuries appears to have the weakest results, according to studies published over the past 10-15 years. Knee chondroplasty using a bipolar radiofrequency-based device have superior short and medium-term results (at 1 year and 4 years respectively). A direct comparison with the other methods discussed above wasn't performed in the study [18]. Very few studies compare the AMIC technique with the microfracture technique (Pubmed search), of which one randomized trial analyzes the short and medium-term results of 38 patients with grade III or IV articular cartilage lesions (10 patients treated with MF, 15 with AMIC - glued membrane, 13 with AMIC - sutured membrane), concluding that the AMIC technique is a safe technique with good functional results [19].

The limits of this study are given by the small number of patients included, which inevitably leads to a possible Type II error (the impossibility of rejecting the null hypothesis when it is false). Also, short-term follow-up and lack of randomization limit the statistical power of the study. The strengths of this study are related to an early comparison of the results obtained at 6 months for all 4 treatments proposed for evaluation in patients with similar cartilage joint injuries, operated by the same surgical team, which benefited from a similar rehabilitation program.

Conclusions

Patients with articular cartilage lesions classified Outerbridge III or IV who underwent chondral repair procedures obtained superior functional results at 6 months postoperatively for AMIC and OATS techniques compared to microfractures and mechanical debridement.

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Manuscript received: 20.08.2018